Studies on Neotropical Fauna and Environment
2001, Vol. 36, No. 2, pp. 105–112

0165-0521/01/3602-105$16.00

A New Species of Minute *Hyla* from the Southwestern Amazon Basin (Amphibia, Anura, Hylidae)

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Abstract

Hyla joannae spec. nov., a new small species of hylid frog, is described from Cobija, Departamento Pando, northern Bolivia. The new species is most similar to *Hyla leali* from which it differs mainly by smaller size, shorter snout, more protuberant eyes, more tuberculate dorsal skin, and a red inner iris in life. Morphological characters and advertisement call of *Hyla joannae* spec. nov. suggest it being related to the *Hyla microcephala* group. Differences in recordings of *Hyla leali* calls are discussed and compared to calls of the new species.

Keywords: *Hyla joannae* spec. nov., *Hyla leali*, Hylidae, Amphibia, calls, Amazonia.

Introduction

One of the taxonomically most confusing complexes of hylid frogs in the Neotropics is probably that one comprised of numerous species of small tree frogs in the genus *Hyla* that have complex advertisement calls and are predominantly yellow at night. The taxonomic status of certain of these *Hyla* occurring in the Amazon basin has been in an almost permanent state of flux since their descriptions. One reason for the confusion is the absence of well-defined phylogenetic species groups. For most of the species, data on larval morphology, chromosomes, advertisement call, and osteology are incomplete and prevent a proper analysis of relationships. The species groups defined are based on phenetic similarities only and include the *Hyla microcephala* group (Duellman & Fouquette, 1968; Duellman, 1970), the *Hyla leucophyllata* group (Cochran & Goin, 1970; Duellman, 1974), the *Hyla parviceps* group (Duellman & Crump, 1974), the *Hyla columbiana* group (Duellman & Trueb, 1983), and the *Hyla minima* group (Duellman, 1982). The complex of species similar to *H. minuta* was long time believed to represent a group of close relatives, but Kaplan (1994) demonstrated that *H. minuta*-like frogs may belong to completely different lineages. Over time, certain species were moved from one group to another.

During field work in January 1998, in the Amazon of northernmost Bolivia, we discovered an undescribed species of small *Hyla* (see Köhler & Lötters, 1999). It seems to be closely related to *Hyla leali*, a taxon for long time confused with *H. rossalleni* whose taxonomic status was recently clarified by De la Riva and Duellman (1997). In the original description, *H. leali* was compared to *H. minuta* (Bokermann, 1964). Later, the species was placed within the *H. minima* group by Duellman (1982), but subsequent authors (e.g., Márquez et al., 1993) considered it to represent a member of the *H. microcephala* group. Actual relationships remain unclear, but the characteristics of *H. leali* and the new species argue for affinities to the *H. microcephala* group.

Material and methods

Notes on color in life and ecology were taken in the field, as were color slides of specimens. Geographic position was obtained with a Magellan 3000 XL GPS receiver. Advertisement calls were recorded using Sony WM-D6C or Aiwa HS-F150 tape recorders, Sennheiser Me-80 directional microphones, and TDK MA60 cassettes. Recordings were

Received: 16 May 2000
Accepted: 30 June 2000

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analyzed with the sound analysis software Cool Edit 96 (Syntrillium Software Corp.) on IBM compatible computers and were sampled with a rate of 22.05 kHz and 16-bit resolution. Frequency information was obtained through fast Fourier transformation (FFT, width 1024 points). Terminology in call descriptions follows Heyer et al. (1990). Note repetition rate was calculated within calls and pulse repetition rate within notes.

Morphometric measurements are given in millimeters (mm) and were taken to the nearest 0.1 mm using dial calipers. They were taken in the manner described by Duellman (1970). Webbing formulae follow the standards of Myers and Duellman (1982), description of eye coloration follows Glaw and Vences (1997). Morphometric abbreviations used throughout the text are: E–N, eye to nostril distance; FL, foot length; HL, head length; HW, greatest head width; IOD, interorbital distance; SVL, snout-vent length; TL, tibia length. Institutional abbreviations are as listed in Leviton et al. (1985) with the following additions: CBF, Colección Boliviana de Fauna, La Paz; NKA, amphibian collection, Museo de Historia Natural 'Noel Kempff Mercado', Santa Cruz de la Sierra.

Results

***Hyla joannae* spec. nov.** (Figs. 1, 3)

Hyla species A – Köhler & Lötters (1999)
Hyla species B – Köhler (2000)

Holotype

CBF 3323, adult ♂, from Cobija (11°00′45″S, 68°45′27″W), 250 m above sea level, Provincia Nicolás Suárez, Departamento Pando, Bolivia; collected on 13 January 1998 by J. Köhler and S. Lötters.

Paratypes

CBF 3324–26, KU 224701–03, ZFMK 67119–20, 67123–24, 10 adult ♂♂, and ZFMK 67121–22, 2 adult ♀♀, all from Cobija and its vicinity; collected on 13–16 January 1998 by J. Köhler and S. Lötters.

Diagnosis

A small species of *Hyla* defined by the following combination of characters: (1) adults small, maximum SVL 18.6 mm in males, 20.6 mm in females; (2) snout short, rounded; (3) canthus rostralis rounded in cross-section; (4) tympanic membrane and tympanic annulus distinct, round, its diameter about one third of eye diameter; (5) vomerine teeth present, small, between choanae; (6) skin on dorsal surfaces finely tuberculate; (7) tubercles on outer edge of tarsus and outer edge of forearm absent; (8) axillary membrane poorly developed; (9) fingers about two fifth webbed; toes about four fifth webbed; (10) bifid distal subarticular tubercle under fourth finger; (11) suborbital bar absent; (12) dorsolateral stripes absent; (13) dorsum grayish or yellowish tan with brown markings; dorsal surfaces of finger and toe discs bright yellow in life; (14) eye periphery black, inner iris bright red in life.

Hyla joannae is most similar to *H. leali* (Figs. 2, 3) from which it is distinguished mainly by smaller size, shorter snout, more protuberant eyes (Fig. 2), more tuberculate dorsal skin, and a red inner iris in life. *Hyla cruzi* is similar to *H. joannae* in size and coloration but differs from it by a more pointed snout, a less distinct tympanum, a copper colored iris in life, and in characters of the advertisement call (see Pombal & Bastos, 1998). *Hyla riveroi* is distinguished mainly by its smooth dorsal skin, presence of an outer metatarsal tubercle, dorsal color pattern, and advertisement call. The central Amazonian *H. minima* is distinguished from the new species by having a concealed tympanum, and *H. aperomea* from the Amazonian slopes of the Peruvian Andes exhibits a white supra-anal stripe, a single distal subarticular tubercle under the fourth finger, and a gray iris in life. Species seemingly related to *Hyla minuta* (including *H. xapuriensis*, *Hyla minuta* and its recognized synonyms) exhibit a white supra-anal stripe and moreover differ by their iris coloration. Furthermore, the new species is distinguished from members of the *H. parviceps* group by the presence of a distinct tympanic annulus and the absence of suborbital bars or flecks. From species of the *H. leucophyllata* group, *H. joannae* differs by the absence of bright yellow or orange markings on dorsal surfaces and the lack of a well-developed axillary membrane. Other small species of *Hyla* known from the Amazon basin include *H. haraldschultzi*, *H. microcephala*, *H. minuscula*, *H. miyatai*, *H. nana*, *H. rhodopepla*, *H. schubarti*, *H. tintinnabulum*, *H. tritaeniata*, and *H. walfordi*. All of these differ at least by their dorsal color pattern and by lacking a bright red inner iris in life.

Description of holotype

Body slender; head about as wide as body, longer than wide, widest below eyes; snout bluntly rounded in dorsal view, rounded in lateral profile; distance from nostril to corner of eye shorter than diameter of eye; canthus rostralis rounded; loreal region slightly concave; lips not flared; internarial area not depressed; nostrils barely protuberant, directed dorsolaterally; interorbital area flat, IOD 125% of eyelid width; eye large, protuberant, its diameter about six times depth of lip below eye; tympanic membrane round, distinct, its diameter about one third of eye length, separated from eye by a distance of about its diameter; tympanic annulus prominent; supratympanic fold evident, slightly obscuring upper edge of tympanum. Arm slender, not hypertrophied; axillary membrane extending to mid-length of upper arm; ulnar folds and tubercles absent; fingers short, bearing large, round discs; relative length of fingers 1 < 2 < 4 < 3; diameter of disc on

Fig. 1. Living holotype of *Hyla joannae* spec. nov. (CBF 3323) in dorsolateral view. SVL 18.1 mm.
Fig. 2. *Hyla leali* from Mataracú, Provincia Ichilo, Departamento Santa Cruz, Bolivia. Specimen deposited in the NKA (number not available).

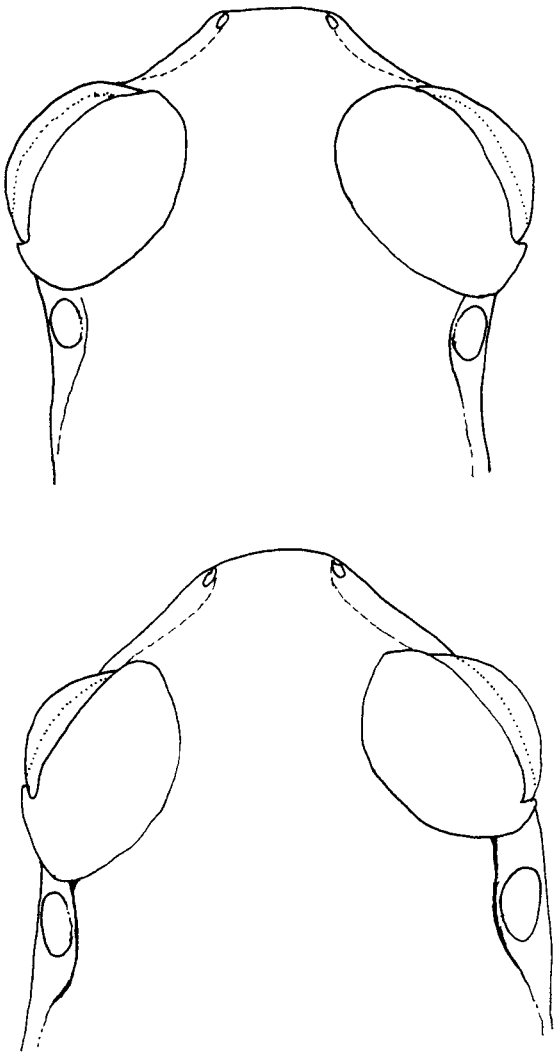

Fig. 3. Schematic drawings of the heads of *Hyla joannae* spec. nov. (ZFMK 67119; above) and *Hyla leali* (ZFMK 62826; below) in dorsal view. Note the protruding eyes in *H. joannae* spec. nov. and the differences in snout shape.

third finger about the size of tympanum; subarticular tubercles small, round, distal one of fourth finger prominent, bifid; supernumerary tubercles small, barely evident; palmar tubercle small, ovoid; prepollical tubercle large, flat, ovoid, lacking nuptial excrescences; webbing on hand I1–2^{+}II1/2–1^{+}III1–1IV. Legs moderately long, slender; heels broadly overlapping when limbs flexed perpendicular to axis of body; tarsal fold and tarsal tubercles absent; toes moderately short, bearing round discs of about same size than those of fingers; relative length of toes 1 < 2 < 3 = 5 < 4; outer metatarsal tubercle absent; inner metatarsal tubercle moderately large, elliptical; subarticular tubercles small, round; supernumerary tubercles not evident; webbing on foot I1/2–1II0^{+}–1III0^{+}–1IV1–0^{+}V. Skin on dorsum, head, and dorsal surfaces of limbs finely tuberculate; skin on flanks shagreened; skin on venter coarsely granular; skin on throat smooth. Anal opening directed posteriorly at upper level of thighs; anal sheath short, covering upper edge of anal opening; anal folds and tubercles absent. Tongue nearly round, posterior third not attached to floor of mouth; vomerine odontophores small, prominent, separated medially, between choanae, each bearing three vomerine teeth; choanae moderately sized, ovoid; vocal slits long, extending from midlateral base of tongue to angle of jaws; vocal sac large, single, median, subgular.

Color in alcohol

Dorsal surfaces of head, body, and limbs grayish tan with brown markings consisting of a triangular interorbital bar, two nearly parallel longitudinal bars extending from scapular region to middle of body, followed by a transverse bar sacrally and an irregular fleck postsacrally, small scattered spots, three indistinctly defined transverse bars on forearm, and three broad transverse bars on shank; upper lip and tympanum whitish; brown fleck posteriorly to tympanum; two separated brown flecks surrounding nostrils; loreal region whitish; posterior surfaces of thighs as well as dorsal surfaces of hands, feet and webbing cream with scattered chromatophores; ventral surfaces uniform cream, no pattern on belly, chest, or throat.

Color in life

Dorsum pale yellowish tan with brown markings, flanks and groin yellowish, dorsal surfaces of finger and toe discs bright yellow; ventral surfaces of limbs and belly fleshy transparent, chest cream, throat yellowish; inner iris bright red, narrow tan ring on outer iris, eye periphery black; bones white.

Measurements

SVL 18.1; TL 8.9; FL 13.0; HW 5.3; HL 6.0; eyelid width 1.6; IOD 2.0; tympanum diameter 0.9; eye length 2.7; E–N 1.8.

Variation

Variation is evident in shape and distinctness of the brown dorsal markings. In four individuals, the triangular interorbital bar is posteriorly connected with a dorsal chevron-shaped mark. Half of the specimens show a dorsal chevron, whereas the other half exhibit one single or two longitudinal bars at the same place. The transverse bar in the sacral region is divided in CBF 3324 and indistinct in ZFMK 67120. The dorsum of the latter specimen has numerous scattered brown spots and hence has a darker appearance. In life, the dorsal ground color of the female ZFMK 67122 was grayish tan, as was the ring on the outer iris.

Variation in measurements and proportions of the eleven males of the type series is as follows (range, mean ± SD in parentheses): SVL 15.3–18.6 (17.2 ± 0.9); TL 7.9–9.3 (8.8 ± 0.4); FL 11.9–13.2 (12.7 ± 0.4); HW 4.9–5.7 (5.2 ± 0.3); HL

5.4–6.2 (5.7 ± 0.3); eyelid width 1.5–2.1 (1.7 ± 0.2); IOD 1.7–2.6 (2.2 ± 0.3); tympanum diameter 0.7–0.9 (0.8 ± 0.1); eye length 2.4–3.1 (2.6 ± 0.2); E–N 1.2–1.8 (1.6 ± 0.2). TL/SVL 0.48–0.55 (0.51 ± 0.02); HW/HL 0.84–0.96 (0.91 ± 0.04); E–N/eye length 0.45–0.66 (0.58 ± 0.08); eyelid width/IOD 0.60–0.90 (0.76 ± 0.09); tympanum diameter/eye length 0.28–0.33 (0.31 ± 0.02). The two obtained females are larger than males and have the following measurements: SVL 19.7, 20.6; TL 10.1, 10.3; FL 14.2, 14.9; HW 5.7, 5.5; HL 6.7, 6.4; eyelid width 1.6, 2.0; IOD 2.6, 2.4; tympanum diameter 1.0, 1.0; eye length 2.9, 3.0; E–N 1.7, 1.7.

Advertisement call

The call (Fig. 4) consists of a high pitched pulsed note followed by three to five shorter secondary notes repeated at regular intervals. The first note always consists of six pulses, whereas the following shorter secondary notes have only two or three pulses. An upward frequency modulation is recognizable within the longer first note. Numerical call parameters are as follows (range followed by mean ± SD in parentheses): call duration 571–949 ms (697.8 ± 121.2); notes per call 4–6 (4.7 ± 0.7); note duration, 67–74 ms (72.3 ± 2.7) in long notes; note duration 20–39 ms (29.4 ± 5.6) in short notes; notes per second 5.5–6.3 (5.8 ± 0.3); pulses per second, 86.9–88.9 (87.3 ± 0.7) in long notes; pulses per second 100.0–111.1 (107.4 ± 6.3) in short notes; calls per minute 30.6–36.6 (33.6 ± 3.0); dominant frequency range 2600–7800 Hz; maximum call energy at 6621–7073 Hz (6949 ± 127). Nineteen calls of two individuals were analyzed. Air temperature was 23.2°C at time of recording.

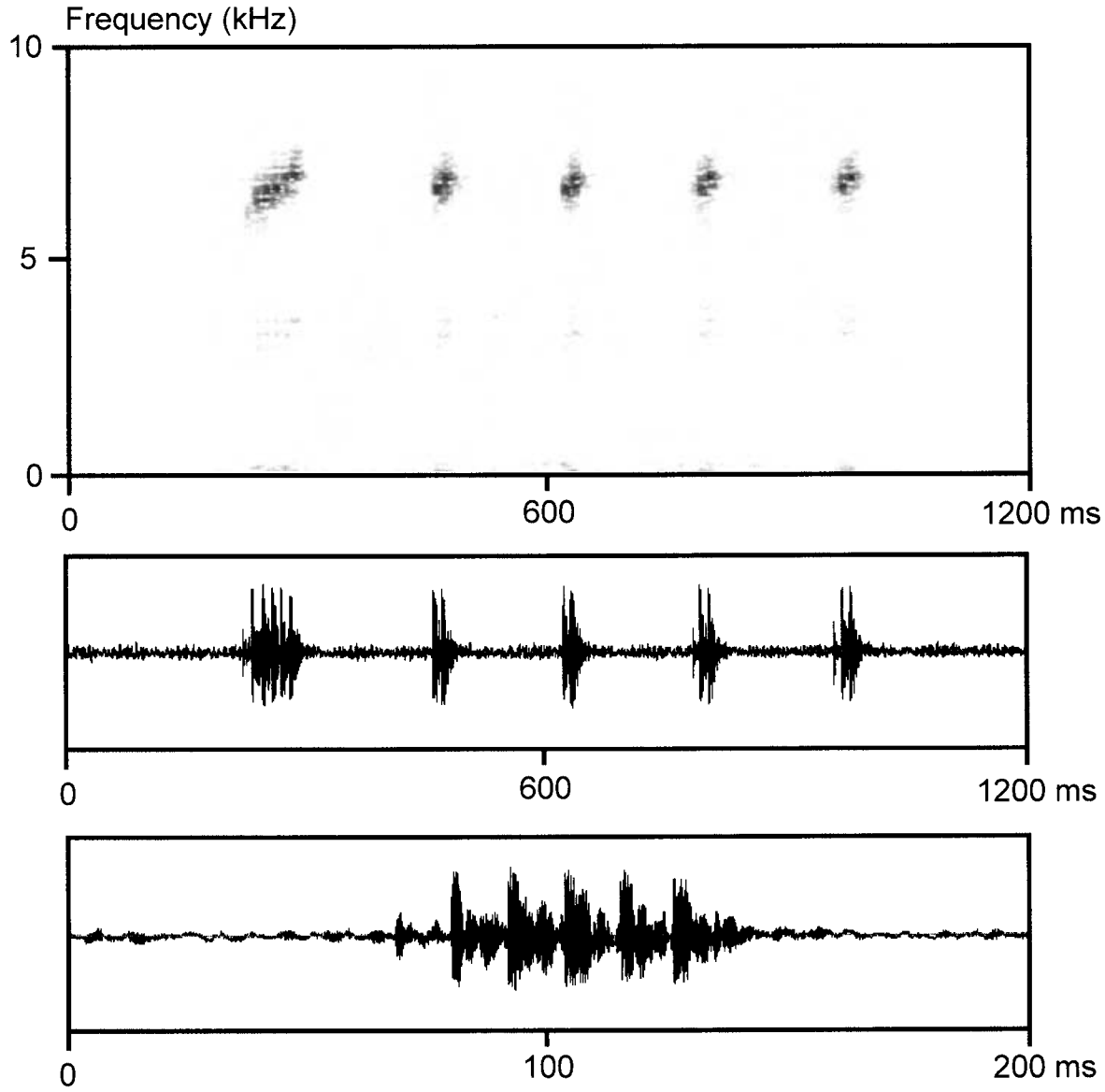

Fig. 4. Audiospectrogram and waveform of the advertisement call of *Hyla joannae* spec. nov. (CBF 3323). The expanded waveform figures the longer first note. Recording obtained on 13 January 1998 at Cobija, Bolivia. Air temperature 23.2°C.

Distribution and ecology

Hyla joannae is known only from Cobija and its vicinity. Its occurrence in neighboring Brazil, only a few hundred meters apart from the type locality, is more than probable. In addition, Kapfer (1998: Fig. 5) figured a specimen of *Hyla* from the Amazon basin of southern Peru which may correspond to *H. joannae*.

Cobija is located within the south-western Amazonian basin, exhibiting a humid but seasonal climate. The dry season occurs from May to August. Mean annual precipitation is 1855 mm, mean annual temperature is approximately 26.0°C (mean values from 1986 to 1995, taken at Cobija airport).

At night, males called from dense grassy vegetation, approximately 0.2–1.0 m above small shallow puddles along the road, individually or in small choruses. Usually, the calling posture was with the head turned down on vertical vegetation structures. Two amplectant pairs were observed on 14 January 1998 during a light rain. Captured in a plastic bag together with two males, the female ZFMK 67121 laid a sticky clutch containing 207 eggs with one hemisphere darkly pigmented, each measuring approximately 1.0 mm in diameter. Tadpoles are unknown. Other species of *Hyla* found in syntopy with *H. joannae* were *H. acreana*, *H. lanciformis*, *H. leucophyllata*, *H. minuta*, *H. parviceps*, *H. punctata*, and *H. riveroi*.

Etymology

The specific name is dedicated to Mrs. JoAnn Oxley Foster (Prescott, Arizona) in recognition of supporting taxonomic research and nature conservation.

Discussion

Morphological as well as advertisement call characters of *Hyla joannae* suggest a relationship to the *H. microcephala* group. The same could be stated for *H. leali*, although the call published for this species was considered to consist of one note type only (Márquez et al., 1993), rather than of two note types like described for other species in the *H. microcephala* group (e.g., Duellman, 1972). Márquez et al. (1993) described the call of *H. leali* from Puerto Almacén, northern Departamento Santa Cruz, Bolivia. The authors found note durations from 34–92 ms, with a variable pulse rate of 79–167 pulses per second; the dominant frequency was remarkably low for such small frogs (mean 118.3 Hz). Additional call energy was present at 3058–3553 Hz. Our analyses of *H. leali* calls obtained in the southern Beni savannas, Departamento Beni, Bolivia, also revealed significant differences in note duration (19–108 ms) which generally coincide with the results of Márquez et al. (1993). In contrast, the dominant frequency in recordings of the Beni population is significantly higher (mean 6600 Hz). Thus, the calls obtained from the Beni population appear more similar to those of the newly described *H. joannae* than those of *H. leali* described by Márquez et al. (1993). *Hyla leali* calls recorded at Cuzco Amazonico, Peru, exclusively consist of long notes of generally more than 80 ms duration. In these recording, the dominant frequency varies between 6100 and 6700 Hz. Summarizing, the note duration in calls of *H. leali* varies considerably and these differences might be interpreted in the same way like in calls of other members of the *H. microcephala* group (i.e., as two different note types). The low dominant frequencies reported by Márquez et al. (1993) in calls of *H. leali* and *H. rhodopepla* obviously reflect amplitude modulation generated by the laryngial glottis and is not to be confused with the carrier frequency generated by the vocal cords (see Bradbury & Vehrencamp, 1998). In our experience, a very short distance between the microphone and the calling frog individual may account for recordings with 'over-representation' of frequencies which are due to amplitude modulation. However, in these cases recordings sounded distinctly distorted. As demonstrated, the call of *Hyla leali* might be similar to that of *H. joannae*, but unlike in *H. joannae* the notes in calls of *H. leali* seem not to follow a discernible pattern. Calls of *H. joannae* always start with a long note followed by shorter secondary notes.

The calls figured by Hödl (1977) as those of *Hyla rossalleni* from near Manaus, Brazil, coincide in general structure with that of *H. joannae*. However, the given sizes for calling males are larger than those of *H. joannae* and the long first note appears to be composed of a larger number of pulses. The call figured by Hödl (1977) probably corresponds to a species in the *H. microcephala* group (*H. rossalleni* is a member of the *H. leucophyllata* group and actually occurs in central Amazonia; De la Riva & Duellman, 1997; Hödl, 2000), but with the data at hand it is not possible to state if it corresponds to *H. leali* or another related species. A similar case might be the description of the call of *H. rossalleni* by Schlüter (1979). The author described the call as a high-pitched trill which might be confused with the call of *H. rhodopepla*. In the provided spectrogram, maximum call energy of the two-note call (long and short note) is distributed between 2500 and 4000 Hz. Again, the specific identity of this population remains unclear. Further investigations might reveal that some of the populations regarded to represent *H. leali* or those which were mistakenly called *H. rossalleni* in the past actually correspond to *H. joannae*. However, taking into account the variability in call characteristics published as well as the morphological variation of figured specimens, it seems to be probable that additional species are still contained in this complex of little *Hyla*.

Although we suspect a relationship of *Hyla joannae* and *H. leali* to the *H. microcephala* group, no definite statement about their phylogenetic position is possible. It might also be that both species actually are more closely related to frogs placed in the poorly defined *H. minima* group. Beside *H. minima* itself, the species *H. aperomea*, *H. leali*, *H. riveroi*, and *H. miyatai* were associated with this group (Duellman, 1982; Vigle & Goberdhan-Vigle, 1990). At

present, too few is known about these species and their relationships.

Additional specimens examined

Hyla aperomea: PERU: *Amazonas*: 8 km NNE of Balzapata, 1850 m, KU 181812 (holotype).
Hyla leali: BOLIVIA: *Beni*: El Porvenir, 300 m, CBF 2449–50, ZFMK 62826; Totaizal, CBF 2358–61; Bosque Chimanes, CBF 1859–60; Ifierno Verde, CBF 1861–62; Puerto Almacén, Río Ibaré, ZFMK 60721–22; Rurrenabaque, 200 m, CBF 1080. *Cochabamba*: 6.5 km N Chipiriri, 260 m, KU 136281–94. BRAZIL: *Rondônia*: Forte Príncipe de Beira, KU 92058–59 (paratypes). PERU: *Madre de Dios*: Cuzco Amazonico, 15 km E Puerto Maldonado, 200 m, KU 205488–92, 205498–590, 207577–79.
Hyla minima: BRAZIL: *Amazonas*: Taperinha (near Santarem, NMW 19436 (holotype).
Hyla riveroi: BOLIVIA: *Beni*: El Trimefo, CBF 1960–90; road San Borja–Trinidad, Río Matos, CBF 2456–57; Totaizal, CBF 2691. *Pando*: Cobija, 250 m, ZFMK 67145–48. *Santa Cruz*: Buenavista, 250 m, three yet uncatalogued ZFMK specimens. COLOMBIA: *Amazonas*: Leticia, CM 37433 (holotype).

Acknowledgements

We are indebted to James Aparicio of the Colección Boliviana de Fauna, La Paz, for his collaboration. The Fundación Amigos de la Naturaleza, Santa Cruz de la Sierra, kindly provided working space and facilities. William E. Duellman and Steffen Reichle kindly provided tape recordings of calls of *Hyla leali* for comparisons. Through the hospitality of William E. Duellman and Linda Trueb, we were able to examine specimens at KU. Field work in Bolivia was funded by grants of the German Academic Exchange Service (DAAD) and the 'Graduiertenförderung des Landes Nordrhein-Westfalen'.

References

Bokermann WCA (1964): Dos nuevas especies de *Hyla* de Rondônia, Brasil. *Neotropica 10*: 2–6.

Bradbury JW, Vehrencamp SL (1998): *Principles of animal communication.* Sinauer Assoc Sunderland Massachusetts.

Cochran D, Goin CJ (1970): Frogs of Colombia. *US Nat Mus Bull 288*: 1–655.

De la Riva I, Duellman WE (1997): The identity and distribution of *Hyla rossalleni* Goin. *Amphibia-Reptilia 18*: 433–436.

Duellman WE (1970): The hylid frogs of Middle America. *Monogr Mus Nat Hist Univ Kansas 1*: 1–753.

Duellman WE (1972): The systematic status and life history of *Hyla rhodopepla* Günther. *Herpetologica 28*: 369–375.

Duellman WE (1974): A reassessment of the taxonomic status of some Neotropical hylid frogs. *Occ Pap Mus Nat Hist Univ Kansas 27*: 1–27.

Duellman WE (1982): A new species of small yellow *Hyla* from Perú (Anura: Hylidae). *Amphibia-Reptilia 3*: 153–160.

Duellman WE, Crump ML (1974): Speciation in frogs of the *Hyla parviceps* group in the upper Amazon basin. *Occ Pap Mus Nat Hist Univ Kansas 23*: 1–40.

Duellman WE, Fouquette MJ Jr (1968): Middle American frogs of the *Hyla microcephala* group. *Univ Kansas Publ Mus Nat Hist 17*: 517–557.

Duellman WE, Trueb L (1983): Frogs of the *Hyla columbiana* group: taxonomy and phylogenetic relationships. In: Rhodin AGJ, Miyata K, eds., *Advances in herpetology and evolutionary biology*. Cambridge Mass, Mus Comp Zool Harvard Univ: pp. 33–51.

Glaw F, Vences M (1997): Anuran eye colouration: definitions, variation, taxonomic implications and possible functions. In: Böhme W, Bischoff W, Ziegler T, eds., *Herpetologia Bonnensis*. Bonn, Proceedings 8th SEH-Meeting, pp. 125–138.

Heyer WR, Rand AS, da Cruz CAG, Peixoto OL, Nelson CE (1990): Frogs of Boracéia. *Arq Zool São Paulo 31*: 237–410.

Hödl W (1977): Call differences and calling site segregation in anuran species from Central Amazonian floating meadows. *Oecologia 28*: 351–363.

Hödl W (2000): Die Frösche der schwimmenden Wiesen. *Aquar Terr Z Sonderh Frösche Kröten*: 26–31.

Kapfer M (1998): Froschbeobachtungen aus dem Amazonastiefland. *Aquar Terr Z 51*: 583–587.

Kaplan M (1994): A new species of frog of the genus *Hyla* from the Cordillera Oriental in northern Colombia with comments on the taxonomy of *Hyla minuta*. *J Herpetol 28*: 79–87.

Köhler J (2000): Amphibian diversity in Bolivia: a study with special reference *t*o montane forest regions. *Bonn Zool Monogr 48*: 1–244.

Köhler J, Lötters S (1999): Annotated list of amphibian records from the Departamento Pando, Bolivia, with description of some advertisement calls. *Bonn zool Beitr 48*: 259–273.

Leviton AE, Gibbs RH Jr, Heal E, Dawson CE (1985): Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia 1985*: 802–832.

Márquez R, De la Riva I, Bosch J (1993): Advertisement calls of Bolivian species of *Hyla* (Amphibia, Anura, Hylidae). *Biotropica 25*: 426–443.

Myers CW, Duellman WE (1982): A new species of *Hyla* from Cerro Colorado, and other tree frog records and geographical notes from western Panama. *Am Mus Novit 2752*: 1–32.

Pombal JP Jr, Bastos RP (1998): Nova espécie de *Hyla* Laurenti, 1768 do centro-oeste brasileiro e a posição taxonômica de *H. microcephala werneri* Cochran, 1952 e *H. microcephala meridiana* B. Lutz, 1952 (Anura, Hylidae). *Bol Mus Nac Rio de Janeiro 390*: 1–14.

Schlüter A (1979): Bio-akustische Untersuchungen an Hyliden in einem begrenzten Gebiet des tropischen Regenwaldes von Peru (Amphibia: Salentia: Hylidae). *Salamandra 15*: 211–236.

Vigle GO, Goberdhan-Vigle DCI (1990): A new species of small colorful *Hyla* from the lowland rainforest of Amazonian Ecuador. *Herpetologica 46*: 467–473.